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**FEDERAL COMMUNICATIONS COMMISSION**
**Washington, D.C. 20554**

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| In the Matter of | ) | |
| | ) | |
| Models to Determine | ) | CC Docket No. 96-45 |
| Cost of Providing Service | ) | |

**Reply Comments of the**
**Rural Utilities Service**

## Introduction

The Rural Utilities Service (RUS) appreciates the opportunity to offer comment to the Commission on universal service and the proposed computer cost models.

The RUS is a rural development agency of the U.S. Department of Agriculture that has promoted universal service in rural America for 48 years through targeted lending, technical support and policy guidelines. Rural America is comprised of 80% of the landmass of the country, but only 20% of the population. Rural areas are high cost to serve.

The RUS has attempted to evaluate the performance of the BCPM and the Hatfield 3 cost models in estimating the cost to build plant that is capable of providing core services. These comments solely address the most rural of areas, those with 25 subscribers per route mile or less. This paper summarizes the results of those efforts. Note that plant costs, not expenses, are the focus of this evaluation.

## The RUS Cost of Plant

When RUS performs a loan feasibility study, it develops a projected telephone plant in service total, which contains only the plant that will be retained and reused in the proposed system plus all improvements proposed in the loan. This is a calculation of gross plant, before depreciation, which is comparable to the model's projection of total investment. An apples to apples comparison. RUS engineers determine the acceptability of the plant proposed to be retained in the projected system, and determine the original cost of all plant being retired. The original cost of this plant to be retired is then excluded from the RUS cost of plant.

This RUS cost of plant is a cost effective estimate as determined by engineering study and is the cost used for comparison in these Reply Comments and in RUS' previous Comments.

**BCM2 and BCPM**

The BCM2 is capable of being run for many rural areas, and RUS has compared the performance of this model to RUS experience of lending money and engineering projects to provide the Joint Board's recommended core services for 99 projects nationwide. The 99 projects represent all of the projects RUS has financed over the last two years which either will provide the recommended core services or are capable of being tested against the model. The results are shown on graph 1. The 99 projects are sorted along the abscissa by decreasing density (subscribers per route mile). The density is RUS' known density and not the density assumptions made by the models. The model does not accurately predict density. Graph 1 shows that the BCM2 consistently, but not always, calculates a cost to serve that is substantially less than the RUS cost of plant. It shows that the ratio of understatement of cost from project to project is inconsistent. The graph also shows that as system density decreases, BCM2 undershoots the RUS cost of plant by increasing amounts. Very low density projects such as those toward the right-hand side of the graph vary more not only from BCM2 estimates, but from each other as well. RUS experience with lower density projects has been that cost varies greatly from project to project.

RUS did not comprehensibly evaluate the assumptions and inputs of BCM2 because it has been superseded by the BCPM.

The BCPM is supported by its developers with input data to run rural LECs only in Texas, which was a good choice of states. RUS has estimated costs for nine LECs in Texas because of recent loan processing. BCPM and RUS cost of plant were compared for these nine projects and the results are shown on graph 2. RUS sorted these projects so that the graph abscissa represents decreasing density (as known by RUS, not as projected by the model), with the graph ordinate showing plant investment per line. The BCPM estimates costs that are consistently lower than the RUS cost of plant to provide core services, and the difference increases with decreasing density as it did with the BCM2. It should be noted that since these are all Texas projects, they are all fairly low density projects compared to the national sample used to evaluate BCM2.

The BCPM documentation has a clear description of the model's network architecture. RUS uses this architecture in rural areas, and considers it to be efficient and capable of providing the recommended core services. RUS loans are based on this architecture unless special circumstances require otherwise. This is industry standard modern plant design.

RUS has evaluated the cost to build inputs and finds that they are not the cause of the model's inability to accurately rural plant costs.

Two assumptions jump out which are made in the BCPM but are not appropriate for low density areas in RUS' opinion. First, the $10,000 cap on outside plant loop cost is unrealistic. It is based on the assumption that wireless loops can be used to limit the cost of loop plant. As discussed in the RUS Comments, this does not often prove true. RUS pioneered basic exchange telephone radio service (BETRS) and urged the FCC to grant primary licenses for it in the 1980's. RUS has been an advocate of wireless loop plant for many years, has financed BETRS systems, and has promoted it at industry meetings. Despite this strong support of BETRS, RUS finds few cases where it is the most economical way to serve an area. Those $10,000-plus customers need to be grouped, and there need a good number of them, for BETRS to prove in. Mountains block the signal. The $10,000 loop cap plays some part, as can be seen from graph 2, in causing the BCPM to underestimate cost or rural loops, particularly in lower density systems.

Second, the assumption that all subscribers in lower density areas live within 500 feet of a road is often not true. This has the effect of reducing Texas to a state approximately the size of Kansas. Subscribers in some rural areas do live within 500 feet of roads. But in some rural areas subscribers do not. Perhaps this could be made a user-adjustable input.

RUS is also concerned about low interoffice investment and the subscriber multiplier for residential and business lines and is examining these for future comment.

**Summary comments on the BCPM**

Taking into consideration RUS' agreement with the model's plant architecture and partial agreement with its cost-to-build inputs, RUS would expect better performance from the BCPM than is shown in graph 2. This raises two questions: Can a model successfully predict the cost to serve low density areas? And, can a model be trusted to predict the cost to serve low density areas?

**Hatfield 3**

RUS found that, unlike BCPM, the Hatfield model has not been developed to the point where it will run a reasonable cross-section of rural areas. Only four rural systems can run, and only two of those are RUS financed. Those two are the Nucla-Naturita Telephone Company of Colorado, and the Sugar Land Telephone Company, of Texas. Neither of these companies has received a telecommunications loan in recent years from RUS so RUS has not developed an estimated cost for providing core services for either. This prevents meaningful performance testing of the model by RUS. In addition, Sugar Land is not a typical rural company, as can be seen from its profile in Appendix A.

RUS found also that the Hatfield model system architecture could not be evaluated. In contrast to the BCPM, the model documentation did not reveal the system architecture. It can be deduced from the input documentation, however, that the model utilizes inductor loaded loop plant. Surely no new entrant would build a new outside plant based on an antiquated technology that LECs are phasing out. RUS has standardized on non-loaded plant for new construction because it provides superior performance and reliability at a cost that is comparable to loaded plant. It allows for growth without large step-function investments. It gives noise free service even to customers on the longest routes. Non-loaded plant also will support the bandwidth of 4000 Hz recommended by the Joint Board, which loaded plant will not.

The only evaluation that can be made of the Hatfield 3 Model for rural areas, therefore, seems to be an evaluation of Hatfield on the merits of its inputs and assumptions. Those comments follow:

Item II.1., assignment of wire center: The design of wire centers in rural areas, where CBGs are likely to be very large geographically, is a result of factors such as assignment of service area by regulators, presence of physical barriers, and communities of calling interest, rather than pure network efficiency. These real world factors will continue to dominate the design of outside plant networks in rural areas. A model should not usurp these factors when assigning subscribers to wire centers.

Item II.3., calculating lines for CBGs which show no lines. The number of business lines is calculated by multiplying the number of employees by 0.504547. This factor is inappropriate for rural areas, where businesses average few employees. Using this factor would result in businesses having fewer than one line per business. A fair model would assign at least one line to each business.

Appendix B, loading investment per line: Hatfield calculates outside plant costs using a design that has been discarded by the LEC industry as inflexible and inefficient. The Joint Board's Recommended Decision has just provided an additional reason to reject this antiquated design architecture.

Loaded plant will not support the bandwidth of the core services recommended by the Joint Board. H88 loading, the standard loading scheme used by all rural LECs except RUS borrowers, has a best-case cutoff frequency of 3500 Hz, compared to the Recommended Decision high end of 4000 Hz. In actual field conditions, where cable mutual capacitance is not always the ideal 0.083 mf/mile, where load spacing is not exactly 6000 feet, and where end sections are not the ideal half load section of 3000 feet, bandwidth is usually limited to about 3000 Hz. D66 loading, which for 30 years has been the recommended RUS standard, has a design ideal high end cutoff of 4600 Hz, and in real world applications is typically 3500 Hz. Neither loading scheme can be expected to provide core service bandwidth consistently.

The industry employs digital loop carrier (over either fiber or copper plant) in feeder applications to eliminate loaded plant and to facilitate growth efficiently. For about the cost of copper feeder plant, this architecture provides for growth inexpensively, reliably provides 4000 Hz bandwidth, and provides higher reliability and immunity to power line induced noise which once was prevalent in rural circuits.

Distribution and feeder parameters, Appendix B: RUS outside plant averages two-thirds buried, nationwide. However, this plant characteristic should not be subject to averages. LECs in rural areas tend to be either all buried, or mostly aerial. The type of plant used results from the terrain served, the amount of rock underground, and the susceptibility of the area to ice storms. Applying averages will distort most rural plant costs.

Structure sharing, Appendix B: The Hatfield Model assigns 33-40% of the "structure" of buried plant to telephone, with the remainder assigned to other utilities/carriers. In rural areas, this is completely inappropriate, and will significantly distort the cost of serving. Rural LECs have no opportunities to share this structure. Many states make mandatory assignments of sectors of highway right-of-way to different utilities to maintain separation. Failure to maintain adequate separation between facilities of different utilities is a major cause of reliability problems for all utilities. Plowing telephone and electric facilities together is dangerous and in rural areas will lead to high hum and noise levels. For rural areas, there should be no sharing of buried or underground structure.

Drop distance: Drop distance for density zones 0-100 is assumed to be 150 feet. This is far too low for rural areas. Drops for many projects average 500 feet.

Drop cost, per foot for buried drops: RUS has experienced national average construction costs over the last two years for buried drops in the amount of $0.913 cents per foot, compared to the Hatfield default assumption of $0.75.

NID investment per line: Hatfield calculates a network interface device (NID) to cost $25.00, and divides that by six to find a $4 cost per line. RUS has experienced an average nationwide rural cost of $58.41 for a single line NID.

Copper distribution cable, cost per foot: The average estimated cost per foot for all RUS-financed buried cable from 1992 to 1996 was $2.31, including pedestals, splicing, and reel end work, but exclusive of extra difficulty adders. The average cable size installed was about 50 pair. This suggests that the standard mile cost used by Hatfield of $1.63 for 50 pair buried distribution plant is low for rural areas.

Serving area interface (SAI) housing investment: RUS actual experience over the last two years was compared to Hatfield cost defaults for three common rural SAI housings:

| | Hatfield | RUS national average |
|---|---|---|
| 600 pair SAI housing | $1,500 | $2,014 |
| 200 pair SAI housing | 902 | 1,438 |
| 50 pair SAI housing | 300 | 1,222 |

This shows that as SAI pair count gets smaller, the Hatfield defaults increasingly underestimate the cost of rural SAIs.

Hard and soft rock placement multipliers: Hatfield applies multipliers of 3.5 and 2.0 to cable costs to account for the extra difficulty and cost of installing cable in hard and soft rock. RUS has extensive experience with hard and soft rock installation. First, these extra difficulty items should be handled by *adders*, not *multipliers*. The added cost of installing 600 pair cable in hard rock is the same as the added cost of installing 25 pair cable in hard rock. A slot must be either blasted, sawn, or trenched in that rock, and the cable is then laid and backfilled. This supports a cost adder, not a multiplier. A multiplier will overestimate the cost of placing large cables in rock and underestimate the cost of placing small cables in rock.

Second, the ratios are unrealistic. RUS national average costs adders for hard and soft rock placement are $7.97 per foot and $0.37 per foot, respectively.

Town factor: Hatfield assumes that 85% of subscribers are in towns. RUS analysis of rural areas shows that on average for the rural 80% of the landmass of the country, 50% of residents live in towns of up to 5,000. For the portion of rural America served by RUS borrower LECs, the percentage is roughly estimated at 34%. For non-RUS LECs, the percentage is estimated at approximately 56%.

Business penetration ratio: A recent RUS study of RUS LECs found the business penetration factor to be .18, not the .30 assumed by Hatfield.

**Summary comments on Hatfield 3**

The Hatfield 3 model contains many inputs and assumptions which would cause it to underestimate the cost of serving rural areas. It appears that inappropriate loop architecture could be employed, architecture that RUS no longer advocates. The model is difficult to evaluate for rural areas because it will run only 4 rural service areas.

RUS cannot evaluate, let alone validate, the Hatfield 3 model for rural areas.

**Can computer models be used to predict rural costs?**

Computer models apply hypothetical designs to hypothetical study areas to derive information and cost. When wire centers contain many CBGs, this may work. When a wire center contains a few CBGs or even a fraction of a CBG, it does not seem to work. Perhaps for rural areas, study areas smaller than CBGs are needed to improve accuracy. But the hypothetical designs may be the problem.

For a model to calculate accurate cost, it must first calculate the correct system density. This fundamental predictor of plant cost is correctly cited by the BCPM documentation to have multiple major impacts on the cost of serving an area. RUS studied the density calculated by the BCM2 and BCPM for the nine Texas RUS borrower LECs and found that neither model correctly calculated density and no pattern emerged as to why the calculation is inaccurate. A comparison of RUS projected densities (RUS *projected* system density differs slightly from the *actual* system density reported in the 1995 RUS Annual Statistical Report for Telecommunications Borrowers and reflected in Appendix A for these borrower LECs) to the models' projections is set forth below.

**Density**

| Project | RUS[1] | BCM2[2] | BCPM[2] |
|---|---|---|---|
| TX 507 | 1.1 | 4.0 | 3.3 |
| TX 549 | 2.1 | 5.8 | 7.4 |
| TX 562 | 1.8 | 5.3 | 6.4 |
| TX 569 | 0.3 | 13.3 | 16.8 |
| TX 578 | 2.3 | 4.2 | 5.3 |
| TX 592 | 3.2 | 15.8 | 19.6 |
| TX 630 | 0.3 | 1.8 | 2.2 |
| TX 635 | 3.2 | 16.5 | 18.8 |
| TX 654 | 1.0 | NA | 4.7 |

[1]Subscribers per route mile of plant

[2]Subscribers per square mile of plant. But the model assumed that subscribers are located within 500 feet of roadway so there could be a rough proportionality between this method and the RUS subscribers per route mile of plant

Inability to consistently predict density from CBG information may mean that the model is flawed, but if the model consistently predicts densities in urban and suburban areas, it more likely is an indication that models cannot be depended upon to predict rural cost to build in the most rural areas.

It may, however, be that models cannot predict reality. Just like the difficulties with artificial intelligence (a computer still can't beat the world champion in chess), models may not be able to predict the varied American landscape. So far, the models do not replicate the RUS experience with real-life systems.

**Conclusions**

While the BCPM has improved upon the accuracy of the BCM2 for predicting the cost of constructing rural systems, it still does not accurately or consistently predict the cost to build for systems with low densities, those with fewer than 25 access lines per route mile. The Hatfield 3 model is not ready to run for rural America, but RUS found that its input costs and allocations need adjustment before it is offered for rural applications.

Existing rural systems vary in quality and service provided. Some are very good and some are not so good. RUS found in its February 13 Comments that the BCM2 does a better job of predicting cost of plant when small improvements are made to a basically good existing system than when extensive ("near greenfield") improvements are made to systems in need of substantial upgrades to meet a core service level. This model cost understatement for the systems in the worst shape would inhibit the upgrade of the systems that need the most improvement. In fact, the models do not adjust at all for the quality of existing service. Good service providers and not so good service providers get the same support.

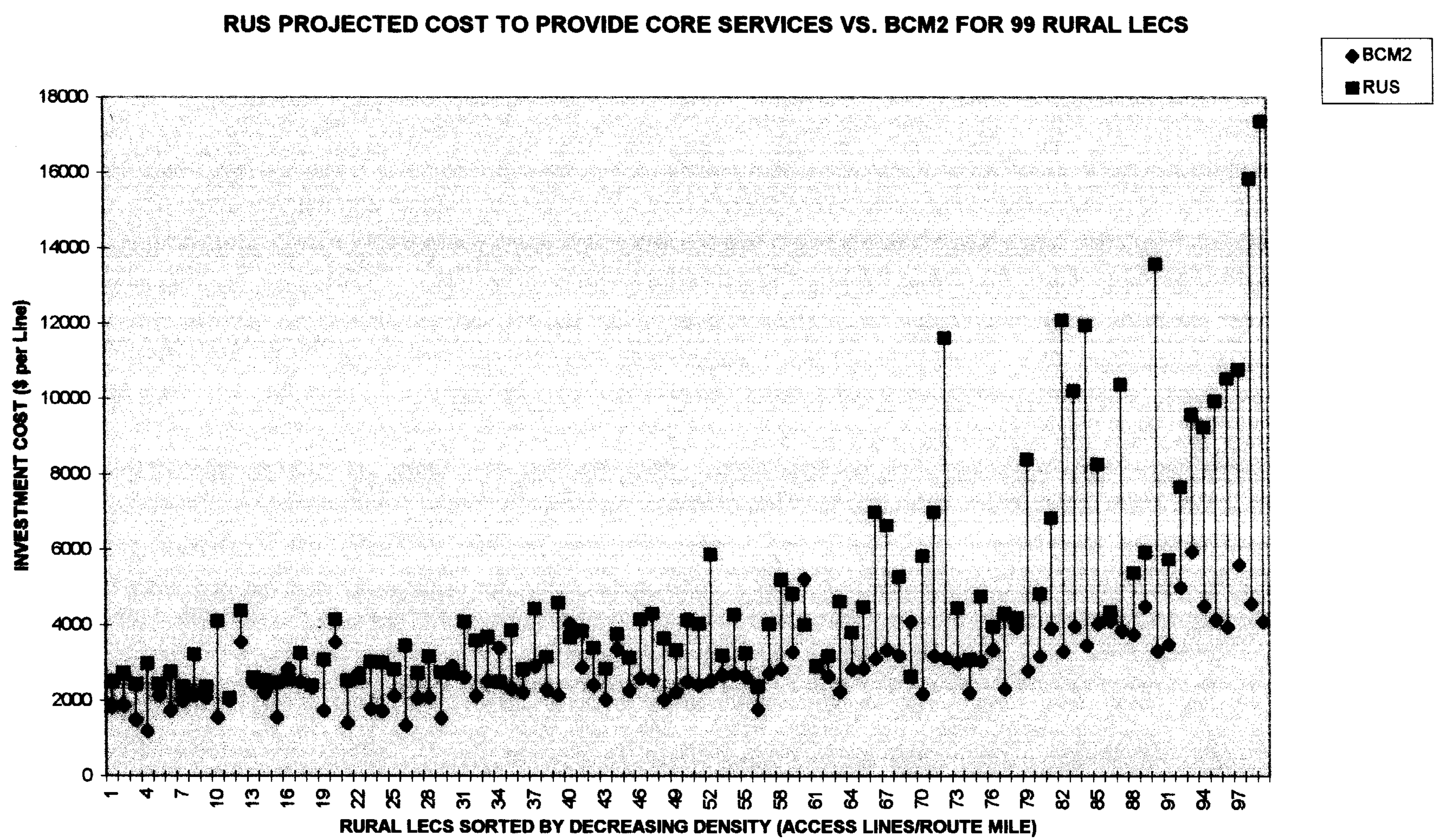
The serious cost divergence as study areas become less dense is a problem for cost models. In rural areas there isn't much averaging of costs, and there are so many factors that cause outside plant costs to exceed average costs that a model may not be able to capture the landscape to be served.

In sum, RUS has evaluated the models and determined that none of them can replicate the cost to build plant to serve the most rural of areas, those with densities of 25 subscribers per mile or less. It may be that models can not accurately account for the varieties of the rural landscape.

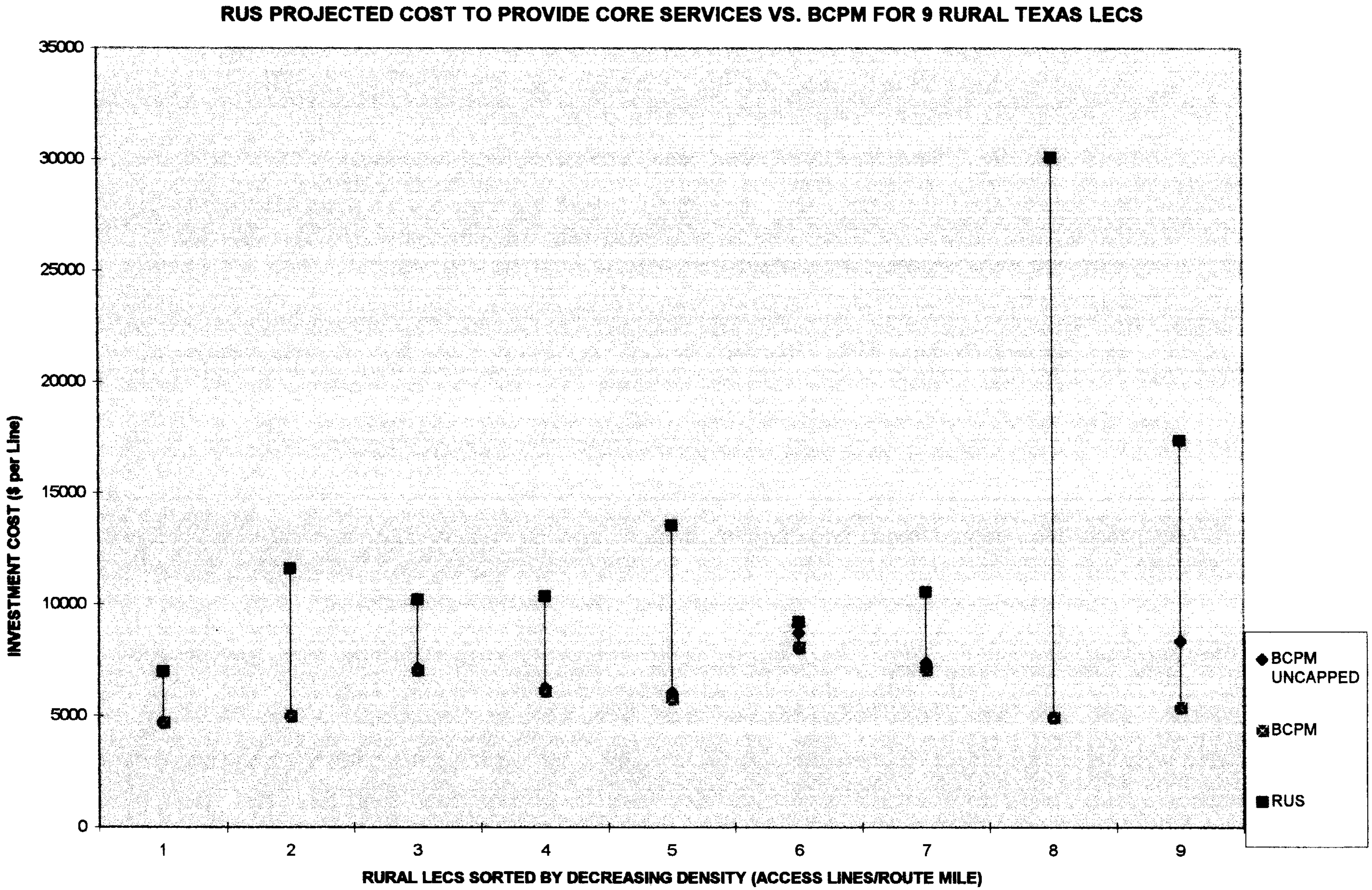
Thank you for the opportunity to comment.

Dated: 2-24-97

for Administrator
Rural Utilities Service


RUS PROJECTED COST TO PROVIDE CORE SERVICES VS. BCM2 FOR 99 RURAL LECS
BCM2
RUS
INVESTMENT COST ($ per Line)
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
1
4
7
10
13
16
19
22
25
28
31
34
37
40
43
46
49
52
55
58
61
64
67
70
73
76
79
82
85
88
91
94
97
RURAL LECS SORTED BY DECREASING DENSITY (ACCESS LINES/ROUTE MILE)

GRAPH 1


RUS PROJECTED COST TO PROVIDE CORE SERVICES VS. BCPM FOR 9 RURAL TEXAS LECS
INVESTMENT COST ($ per Line)
35000
30000
25000
20000
15000
10000
5000
0
1
2
3
4
5
6
7
8
9
RURAL LECS SORTED BY DECREASING DENSITY (ACCESS LINES/ROUTE MILE)
BCPM UNCAPPED
BCPM
RUS

GRAPH 2

## Appendix A
## An Introduction to the Projects Studied

The BCPM and Hatfield 3 models can currently be run for only a few rural projects because the model sponsors have not incorporated the necessary input information to run other rural LECs. RUS ran the BCPM on the nine possible Texas rural LECs supported by the model, and ran Hatfield 3 on the two possible rural LECs which are RUS borrowers. Brief profiles are provided below for the LECs for which these models were run. All statistical information is from the RUS 1995 Statistical Report [for] Rural Telecommunications Borrowers, Informational Publication 300-4.

The BCPM LECs

The LECs which can run on the BCPM together serve an area approximately 13.2% of the area of Texas. Collectively, they serve 25,196 access lines. There are seven cooperatives and one commercial company. All provide one-party service. They are:

1. West Texas Telephone Cooperative, Inc., Hereford, TX (TX 507)

| | |
|---|---|
| Access lines: | 1,818 |
| Exchanges: | 9 |
| Counties served: | 4 |
| Square miles served: | 3,000 |
| Where: | south and west of Amarillo |
| Access lines per square mile: | .6 |
| Miles of route line: | 1,649 |
| Access lines per route mile: | 1.1 |
| All one-party? | yes |
| Employees: | 31 |
| Telephone plant in service per access line: | $7,010 |

2. Central Texas Telephone Cooperative, Inc., Goldthwaite, TX (TX 549)

| | |
|---|---|
| Access lines: | 3,902 |
| Exchanges: | 18 |
| Counties served: | 14 |
| Square miles served: | 3,218 |
| Where: | about 100-300 miles south and west of Dallas |
| Access lines per square mile: | 1.28 |
| Miles of route line: | 3,218 |
| Access lines per route mile: | 1.21 |
| All one-party? | yes |
| Employees: | 40 |
| Telephone plant in service per access line: | $10,605 |

3. Valley Telephone Cooperative, Inc., Raymondville, TX (TX 562)

| | |
|---|---|
| Access lines: | 5,393 |
| Exchanges: | 19 |
| Counties served: | 19 |
| Square miles served: | 7,390 |
| Where: | the southern half of the southern panhandle |
| Access lines per square mile: | .35 |
| Miles of route line: | 4,352 |
| Access lines per route mile: | 1.23 |
| All one-party? | yes |
| Employees: | 77 |
| Telephone plant in service per access line: | $10,466 |

4. Dell Telephone Cooperative, Inc., Dell City, TX (TX 569)

| | |
|---|---|
| Access lines: | 902 |
| Exchanges: | 8 |
| Counties served: | |
| Square miles served: | 10,500 |
| Where: | about 75 miles east of El Paso |
| Access lines per square mile: | 0.08 |
| Miles of route line: | 3,089 |
| Access lines per route mile: | 0.29 |
| All one-party? | yes |
| Employees: | 18 |
| Telephone plant in service per access line: | $25,329 |

5. Coleman County Telephone Cooperative, Inc., Santa Anna, TX (TX 578)

| | |
|---|---|
| Access lines: | 1,956 |
| Exchanges: | 6 |
| Counties served: | 5 |
| Square miles served: | 1,076 |
| Where: | about 150-250 miles west of Dallas |
| Access lines per square mile: | 1.81 |
| Miles of route line: | 967 |
| Access lines per route mile: | 2.02 |
| All one-party? | yes |
| Employees: | 13 |
| Telephone plant in service per access line: | $4,758 |

6. Colorado Valley Telephone Cooperative, Inc., La Grange, TX (TX 592)

| | |
|---|---|
| Access lines: | 5,535 |
| Exchanges: | 6 |
| Counties served: | 6 |
| Square miles served: | 898 |
| Where: | about 75 miles west of Houston |
| Access lines per square mile: | 6.16 |
| Miles of route line: | 2,039 |
| Access lines per route mile: | 2.71 |
| All one-party? | yes |
| Employees: | 41 |
| Telephone plant in service per access line: | $4,637 |

7. Big Bend Telephone Cooperative, Inc., Alpine, TX (TX 630)

| | |
|---|---|
| Access lines: | 4,020 |
| Exchanges: | 15 |
| Counties served: | 9 |
| Square miles served: | 17,593 |
| Where: | from I-10 to the Rio Grande |
| Access lines per square mile: | 0.22 |
| Miles of route line: | 15,276 |
| Access lines per route mile: | 0.26 |
| All one-party? | yes |
| Employees: | 43 |
| Telephone plant in service per access line: | $12,984 |

8. Industry Telephone Company, Industry, TX (TX 635)

| | |
|---|---|
| Access lines: | 1,770 |
| Exchanges: | 3 |
| Counties served: | 5 |
| Square miles served: | 226 |
| Where: | about 50 miles west of Houston |
| Access lines per square mile: | 7.83 |
| Miles of route line: | 574 |
| Access lines per route mile: | 3.08 |
| All one-party? | yes |
| Employees: | 20 |
| Telephone plant in service per access line: | $6,142 |

9. Alenco Communications, Inc., Joshua, TX (TX 654)

| | |
|---|---|
| Access lines: | 802 |
| Exchanges: | 5 |
| Counties served: | 5 |
| Square miles served: | 1,300 |
| Where: | scattered areas of central and far south Texas |
| Access lines per square mile: | 0.61 |
| Miles of route line: | 333 |
| Access lines per route mile: | 2.40 |
| All one-party? | yes |
| Employees: | 10 |
| Telephone plant in service per access line: | $11,147 |

The Hatfield LECs

The Hatfield 3 model can run four rural LECs, two of which are RUS borrowers. One, Sugar Land Telephone Company, is one of RUS' largest and fastest growing borrowers, serving the outlying southwestern suburbs of Houston, Texas. The other, Nucla-Naturita Telephone Company, serves three counties on the Colorado-Utah border. Both are commercial companies and both provide one-party service.

1. Nucla-Naturita Telephone Company, Nucla, CO (CO 520)

| | |
|---|---|
| Access lines: | 1,303 |
| Exchanges: | 5 |
| Counties served: | 3 |
| Square miles served: | 2,581 |
| Where: | far western Colorado |
| Access lines per square mile: | 0.50 |
| Miles of route line: | 436 |
| Access lines per route mile: | 2.98 |
| All one-party? | yes |
| Employees: | 12 |
| Telephone plant in service per access line: | $4,660 |

2. Sugar Land Telephone Company, Sugar Land, TX (TX 617)

| | |
|---|---|
| Access lines: | 50,642 |
| Exchanges: | 9 |
| Counties served: | 1 |
| Square miles served: | 610 |
| Where: | southwest of Houston on perimeter |
| Access lines per square mile: | 83.01 |
| Miles of route line: | 1,557 |
| Access lines per route mile: | 32.52 |
| All one-party? | yes |
| Employees: | 165 |
| Telephone plant in service per access line: | $2,142 |